AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1-45. (Cancelled)

46. (Amended) A method of ablating or changing properties in structure of non-biologic materials laser induced breakdown with a pulsed laser beam, said method comprising the steps of:

generating a beam of one or more laser pulses characterized by a pulse width with a relationship of fluence breakdown threshold versus laser pulse width having a distinct change in slope, having a pulse width approximately equal to or less than a pulse width at which laser induced breakdown becomes essentially accurate; and

directing said beam to the material.

47. (Amended) A method of ablation or changing properties in structure of non-biologic materials laser induced breakdown in a volume characterized by a maximum dimension with a pulsed laser beam comprising:

generating a pulsed laser beam characterized by a pulse width with a relationship of fluence breakdown threshold versus laser pulse width having a distinct change in slope, characterized by a wavelength of operation that is greater than said dimension; and directing said beam to the material.

48. (Amended) A method of ablation or changing properties in structure of non-biologic materials with a pulsed laser beam comprising:

generating a pulsed laser beam characterized by a pulse width with a relationship of fluence breakdown threshold versus laser pulse width having a distinct change in slope, having at least one pulse with a pulse width sufficiently short that the size of the feature created in the material is not substantially limited by thermal diffusion in the material; and directing said beam to the material.

49. (Amended) A method of ablation or changing properties in structure of non-biologic materials characterized by a thermal diffusivity, D, with a pulsed laser beam having a pulse width, T, characterized by a pulse width with a relationship of fluence breakdown threshold versus laser pulse width having a distinct change in slope, said method comprising the steps of:

generating a beam of one or more laser pulses having a pulse width sufficiently short so that the thermal diffusion length $l_{th}=Dt^{1/2}$ in the material is significantly smaller than the absorption depth (1/a), where a is the absorption coefficient for the radiation; and

directing said beam to the material.

50. (Amended) A method of ablation or changing properties in structure of non-biologic materials with a pulsed laser beam characterized by a beam shape and a fluence and a pulse width with a relationship of fluence breakdown threshold versus laser pulse width having a distinct change in slope, comprising, generating a beam

having at least one pulse with a pulse width sufficiently short so that the affected area is substantially determined solely by the beam shape and fluence in relation to the threshold for laser induced breakdown; and

directing said beam to the material.

51.   (Amended)   The method according to any of claims 46-50 wherein the material comprises one or more of an opaque material and a transparent material.

52.   (Amended)   The method according to any of claims 46-50 wherein the material comprises one or more of a metal, a dielectric, and a semiconductor material.

53.   (Amended)   The method according to claim 52 wherein the material comprises at least two layers and laser induced breakdown substantially affects one layer and not the other.

54.   (Amended)   The method of claim 53 wherein the material comprises a layer of metal on glass and laser induced breakdown is induced in the layer of metal.

55.   (Amended)   The method of any of claims 46-50 wherein laser induced breakdown is induced on the surface of the material.

56. (Twice Amended) The method of any of claims 46-50 wherein laser induced breakdown is induced beneath the surface of the material by the beam having maximum intensity at the center of the beam waist.

57. (Amended) The method of any of claims 46-50 comprising irreversibly changing a property of the material.

58. (Amended) The method of claim 57 in which the step of irreversibly changing includes one or more of melting and vaporization.

59. (Amended) The method of claim 56 comprising irreversibly changing a property of the material.

60. (Amended) The method of claim 59 in which the step of irreversibly changing includes one or more of melting and vaporization.

61. (Amended) The method of claim 56 in which laser induced breakdown causes thermal-physical changes in state leading to an irreversible change in the material.

62. (Amended) The method of claim 55 in which the thermal-physical changes in state include one or more of melting and vaporization.

63.   (Amended)   The method of any of claims 46-50 in which laser induced breakdown includes changes caused by one or more of ionization, free electron multiplication, dielectric breakdown, plasma formation, and vaporization.

64.   (Amended)   The method according to any of claims 46-50 comprising generating a short optical pulse having a predetermined duration; stretching such optical pulse in time; amplifying such time-stretched optical pulse, and recompressing such amplified pulse to a pulse width.

65.   (Amended)   The method according to any of claims 46-50 comprising scanning the beam along a predetermined path along the surface of the material.

66.   (Amended)   The method according to any of claims 46-50 comprising scanning the beam along a predetermined path beneath the surface of the material.

67.   (Twice Amended)   The method according to any of claims 46-50 comprising scanning the beam along a predetermined path beneath the surface of the material to induce laser induced breakdown therein to a depth smaller than the Rayleigh range by the beam having maximum intensity at the center of the beam waist.

68.   (Amended)   The method according to any of claims 46-50 comprising laser induced breakdown of a material used in one of micromachining, integrated circuit manufacture and encoding data in data storage media.

69.   (Amended)   The method according to any of claims 46-50 comprising laser induced breakdown in a spot without adversely affecting peripheral areas adjacent to the spot.

70.   (Amended)   The method according to any of claims 46-50 wherein the beam comprises one or more pulses with pulse width in the range of 10 femtoseconds to 10 picoseconds.

71.   (Amended)   The method according to any of claims 46-50 wherein the beam comprises one or more pulses with pulse energy in the range of 1 picojoule to 1 joule.

72.   (Amended)   The method according to any of claims 46-50 wherein the repetition rate is between one pulse per second and 100 million pulses per second.

73.   (Amended)   The method according to any of claims 46-50 wherein the beam comprises one or more pulses with a central wavelength selected from at least one of the following ranges: 100 nm to 200 nm, 200 nm to 300 nm, 300 nm to 700 nm, 700 nm to 1000 nm, 1000 nm to 1100 nm, 1100 nm to 1400 nm, 1400 nm to 1600 nm, 1600 nm to 2000 nm.

74. (Amended) The method according to claim 67 wherein the beam comprises one or more pulses with pulse width in the range of 10 femtoseconds to 10 picoseconds.

75. (Amended) The method according to claim 67 wherein the beam comprises one or more pulses with pulse energy in the range of 1 picojoule to 1 joule.

76. (Amended) The method according to according to claim 67 wherein the repetition rate is between one pulse per second and 100 million pulses per second.

77. (Amended) The method according to according to claim 67 wherein the beam comprises one or more pulses with a central wavelength selected from at least one of the following ranges: 100 nm to 200 nm, 200 nm to 300 nm, 300 nm to 700 nm, 700 nm to 1000 nm, 1000 nm to 1100 nm, 1100 nm to 1400 nm, 1400 nm to 1600 nm, 1600 nm to 2000 nm.

78. (Amended) A method for laser induced breakdown of a non-biological opaque or transparent material with a pulsed laser beam, the material being characterized by a relationship of fluence threshold at which breakdown occurs versus laser pulse width that exhibits a distinct change in slope at a characteristic laser pulse width, said method comprising the steps of:

generating at least one laser pulse which has a pulse width equal to or less than said characteristic laser pulse width; and

directing said pulse to a point at or beneath the surface of the opaque or transparent material.

79.   (Twice Amended)   A method for laser induced breakdown of a metal layer on a glass substrate with a pulsed laser beam, the metal being characterized by a relationship of fluence threshold at which breakdown occurs versus laser pulse width that exhibits a distinct change in slope at a characteristic laser pulse width, said method comprising the steps of:

generating at least one laser pulse which has a pulse width equal to or less than said characteristic laser pulse width; and

directing said pulse to the metal.

80.   (Twice Amended)   A method for laser induced breakdown of a first layer of non-biologic material on another layer of non biological material with a pulsed laser beam, without substantially affecting the first layer, the first layer being characterized by a relationship of fluence threshold at which breakdown occurs versus laser pulse width that exhibits a distinct change in slope at a characteristic laser pulse width, said method comprising the steps of:

generating at least one laser pulse which has a pulse width equal to or less than said characteristic laser pulse width; and

directing said pulse to the first layer.

81. (Added)   A method of ablating or changing properties in structure of non-biologic materials laser induced breakdown with a pulsed laser beam, said method comprising:

generating a beam of one or more laser pulses characterized by a pulse width with a relationship of fluence breakdown threshold versus laser pulse width having a distinct change in slope, having a pulse width approximately equal to or less than a pulse width at which laser induced breakdown becomes essentially accurate;

directing said beam to the material; and

scanning the beam along a predetermined path beneath the surface of the material to induce laser induced breakdown therein to a depth smaller than the Rayleigh range.

82. (Added)   The method according to claim 81 wherein the beam comprises one or more pulses with pulse width in the range of 10 femtoseconds to 10 picoseconds.

83. (Added)   The method according to claim 81 wherein the beam comprises one or more pulses with pulse energy in the range of 1 picojoule to 1 joule.

84. (Added)   The method according to according to claim 81 wherein the repetition rate is between one pulse per second and 100 million pulses per second.

85. (Added)   The method according to according to claim 81 wherein the beam comprises one or more pulses with a central wavelength selected from at least one of the following ranges: 100 nm to 200 nm, 200 nm to 300 nm, 300 nm to 700 nm, 700 nm to 1000 nm, 1000 nm to 1100 nm, 1100 nm to 1400 nm, 1400 nm to 1600 nm, 1600 nm to 2000 nm.

86. (Added)   A method of ablation or changing properties in structure of non-biologic materials laser induced breakdown in a volume characterized by a maximum dimension with a pulsed laser beam comprising:

generating a pulsed laser beam characterized by a pulse width with a relationship of fluence breakdown threshold versus laser pulse width having a distinct change in slope, characterized by a wavelength of operation that is greater than said dimension;

directing said beam to the material; and

scanning the beam along a predetermined path beneath the surface of the material to induce laser induced breakdown therein to a depth smaller than the Rayleigh range.

87. (Added)   The method according to claim 86 wherein the beam comprises one or more pulses with pulse width in the range of 10 femtoseconds to 10 picoseconds.

88. (Added)   The method according to claim 86 wherein the beam comprises one or more pulses with pulse energy in the range of 1 picojoule to 1 joule.

89. (Added)   The method according to according to claim 86 wherein the repetition rate is between one pulse per second and 100 million pulses per second.

90. (Added)   The method according to according to claim 86 wherein the beam comprises one or more pulses with a central wavelength selected from at least one of the following ranges: 100 nm to 200 nm, 200 nm to 300 nm, 300 nm to 700 nm, 700 nm to 1000 nm, 1000 nm to 1100 nm, 1100 nm to 1400 nm, 1400 nm to 1600 nm, 1600 nm to 2000 nm.

91. (Added)   A method of ablation or changing properties in structure of non-biologic materials with a pulsed laser beam comprising:

generating a pulsed laser beam characterized by a pulse width with a relationship of fluence breakdown threshold versus laser pulse width having a distinct change in slope, having at least one pulse with a pulse width sufficiently short that the size of the feature created in the material is not substantially limited by thermal diffusion in the material;

directing said beam to the material; and

scanning the beam along a predetermined path beneath the surface of the material to induce laser induced breakdown therein to a depth smaller than the Rayleigh range.

92.	(Added)	The method according to claim 91 wherein the beam comprises one or more pulses with pulse width in the range of 10 femtoseconds to 10 picoseconds.

93.	(Added)	The method according to claim 91 wherein the beam comprises one or more pulses with pulse energy in the range of 1 picojoule to 1 joule.

94.	(Added)	The method according to according to claim 91 wherein the repetition rate is between one pulse per second and 100 million pulses per second.

95.	(Added)	The method according to according to claim 91 wherein the beam comprises one or more pulses with a central wavelength selected from at least one of the following ranges: 100 nm to 200 nm, 200 nm to 300 nm, 300 nm to 700 nm, 700 nm to 1000 nm, 1000 nm to 1100 nm, 1100 nm to 1400 nm, 1400 nm to 1600 nm, 1600 nm to 2000 nm.

96.	(Added)	A method of ablation or changing properties in structure of non-biologic materials characterized by a thermal diffusivity, D, with a pulsed laser beam having a pulse width, T, characterized by a pulse width with a relationship of fluence breakdown threshold versus laser pulse width having a distinct change in slope, said method comprising:

generating a beam of one or more laser pulses having a pulse width sufficiently short so that the thermal diffusion length $l_{th}=Dt^{1/2}$ in the material is significantly smaller than the absorption depth (1/a), where a is the absorption coefficient for the radiation;

directing said beam to the material; and

scanning the beam along a predetermined path beneath the surface of the material to induce laser induced breakdown therein to a depth smaller than the Rayleigh range.

97. (Added)   The method according to claim 96 wherein the beam comprises one or more pulses with pulse width in the range of 10 femtoseconds to 10 picoseconds.

98. (Added)   The method according to claim 96 wherein the beam comprises one or more pulses with pulse energy in the range of 1 picojoule to 1 joule.

99. (Added)   The method according to according to claim 96 wherein the repetition rate is between one pulse per second and 100 million pulses per second.

100. (Added)   The method according to according to claim 96 wherein the beam comprises one or more pulses with a central wavelength selected from at least one of the following ranges: 100 nm to 200 nm, 200 nm to 300 nm, 300 nm to 700 nm, 700 nm to 1000 nm, 1000 nm to 1100 nm, 1100 nm to 1400 nm, 1400 nm to 1600 nm, 1600 nm to 2000 nm.

101. (Added)   A method of ablation or changing properties in structure of non-biologic materials with a pulsed laser beam characterized by a beam shape and a fluence and a pulse width with a relationship of fluence breakdown threshold versus laser pulse width having a distinct change in slope, comprising:

generating a beam having at least one pulse with a pulse width sufficiently short so that the affected area is substantially determined solely by the beam shape and fluence in relation to the threshold for laser induced breakdown;

directing said beam to the material; and

scanning the beam along a predetermined path beneath the surface of the material to induce laser induced breakdown therein to a depth smaller than the Rayleigh range.

102. (Added)   The method according to claim 101 wherein the beam comprises one or more pulses with pulse width in the range of 10 femtoseconds to 10 picoseconds.

103. (Added)   The method according to claim 101 wherein the beam comprises one or more pulses with pulse energy in the range of 1 picojoule to 1 joule.

104. (Added)   The method according to according to claim 101 wherein the repetition rate is between one pulse per second and 100 million pulses per second.

105. (Added)   The method according to according to claim 101 wherein the beam comprises one or more pulses with a central wavelength selected from at least one of the following ranges: 100 nm to 200 nm, 200 nm to 300 nm, 300 nm to 700 nm, 700 nm to 1000 nm, 1000 nm to 1100 nm, 1100 nm to 1400 nm, 1400 nm to 1600 nm, 1600 nm to 2000 nm.